University of Bahrain
College of Information technology
Department of Computer Engineering

Test (1)

Student Name	
I.D. No.	
Section	

Course Title: Digital Logic
Course number: ITCE 202/250
Semester: 1
Academic Year: 2012/2013
Duration : 1hour 30 minutes
Date: 14th November 2012

Read the following before you start:

1. Write your name, ID and section number
2. Answer all questions.
3. Write your answers on the attached sheets only.

Question	Mark	Mark attained
1	25	
2	20	
3	25	
4	25	
Total	100	

Question [1]: [25 mark]

(a) Convert the following numbers showing all steps. [2 marks each]

$(100110)_{2\text{'s complement}} = (100101)_{1\text{'s complement}}$

$-\ 1$

100101

$(A29)_{16} = (220221)_4$

$(1010\ 0010\ 1001)_2$

$(2\ 2\ 0\ 2\ 2\ 1)_4$

$(13)_{10} = (0100\ \ 0110)_{excess\_3}$

$(7)_{10} = (1000)_{7\text{-}3\text{-}2\text{-}1}$

$(+35)_{10} = (0100011)_{1\text{'s complement}}$

$(-66)_{10} = (10111110)_{2\text{'s complement}}$

(b) Add the following numbers in BCD [5 marks]

$(98)_{10}+(45)_{10}=$

	1001	1000	← 1
+	0100	0101	← 1
	1101	1101	← 1
+	0110	0110	← 1
(0001	0100	0011)	BCD ← 1

c) What is the range of 2's complement numbers that can be represented in 8-bit word length. [3 marks]

$-2^{n-1} \rightarrow +2^{n-1}-1$

$-2^7 \rightarrow 2^7-1$

d) Perform the following operation using 6-bit 2's complement numbers and indicate the case of an overflow. [5 marks]

$(-20)_{10}+(-15)_{10}=$

$(-20)_{10} = (110100)_2$ ⇒ 1

$(-15)_{10} = (10\ 1111)_2$ 1

	1	0	1	1	0	0	1
+	1	1	0	0	0	1	1
1	0	1	1	1	0	1	

overflow 1

Solution

Question [2]: [25 mark]

a- Use Boolean algebra to Simplify the following:

$$a\bar{b}c + \cancel{adc} + bdc + \bar{b}c$$

c.t

(4)

$a\bar{b}c + bdc + \bar{b}c$

(3)

$\bar{b}c(1+a) + bdc$

$\bar{b}c + bdc = c(\bar{b} + bd) = c(\bar{b} + d) = c\bar{b} + cd$

(2) (3)

b- Use Demorgan then simplify the following:

$$\overline{xy \cdot (x \oplus y) \cdot \overline{(\bar{x} + \bar{y})}}$$

(3)

$\overline{xy} + \overline{(x \oplus y)} + (\bar{x} + \bar{y})$

(4)

$\bar{x} + \bar{y} + xy + \bar{x}\bar{y} + \bar{x} + \bar{y}$

$\bar{x} + \bar{y} + xy + \bar{x}\bar{y}$

(2)

$\bar{x}(1 + \bar{y}) + \bar{y} + xy =$

$\bar{x} + \bar{y} + xy = \bar{x} + \bar{y} + x = 1 + \bar{y} = 1$

(2) (2)

Question [3]: [25 mark]

Design a combinational circuit with three inputs, x, y, and z (x being the MSB), and three outputs, A, B, and C (A being the MSB). When the binary input (xyz) is 3, 4, 5, 6, or 7, the binary output (A B C) is one less than the input. When the binary input is 0, 1, or 2, the binary output is two greater than the input.

For the above problem do the following;

a. Construct the truth table of the system.

m	x	y	z		A	B	C
0	0	0	0		0	1	0
1	0	0	1		0	1	1
2	0	1	0		1	0	0
3	0	1	1		0	1	0
4	1	0	0		0	1	1
5	1	0	1		1	0	0
6	1	1	0		1	0	1
7	1	1	1		1	1	0

3 3

b. Find the Minterm expansion of output A in decimal notation.

$A = \sum m(2, 5, 6, 7)$

3 3

c. Find the Maxterm expansion of output C in decimal notation.

$C = \prod M(0, 2, 3, 5, 7)$

3 3

d. Find the minimum sum of products for output B, and draw the circuit using at least one XOR as well as other gates.

$= \sum m(0,1,3,4,7)$

$\prod M(2,5,6)$

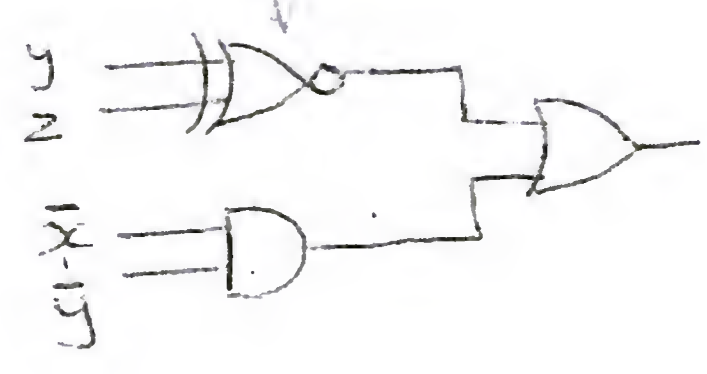
yz \ x	0	1
00	1	1
01	1	0
11	1	1
10	0	0

3

$B = \bar{y}\bar{z} + yz + \bar{x}\bar{y}$ or $B = \bar{y}\bar{z} + yz + \bar{x}z$

$= \overline{y \oplus z} + \bar{x}\bar{y}$ or $B = \overline{y \oplus z} + \bar{x}z$

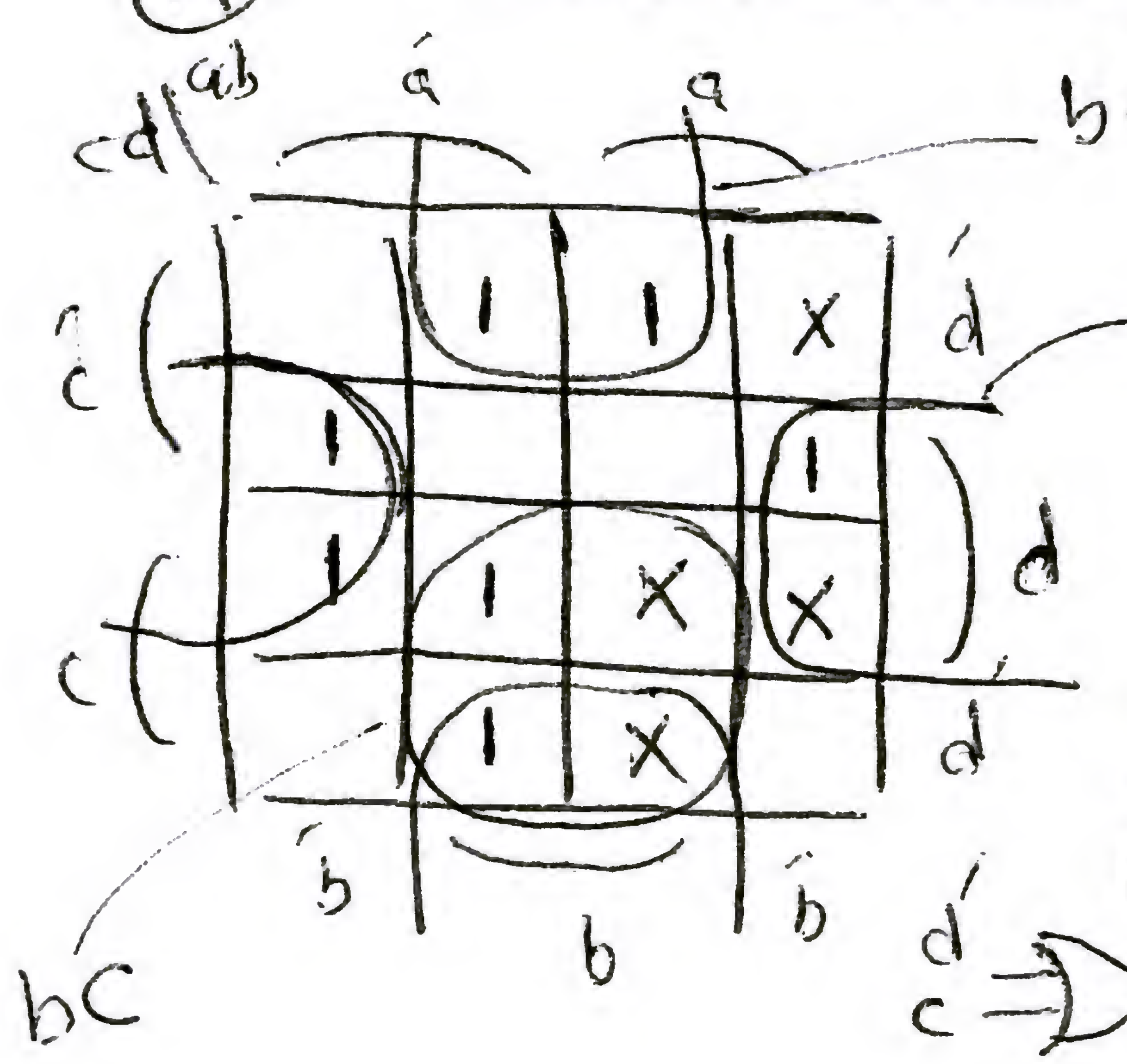
1



Question [4]: [25 mark]

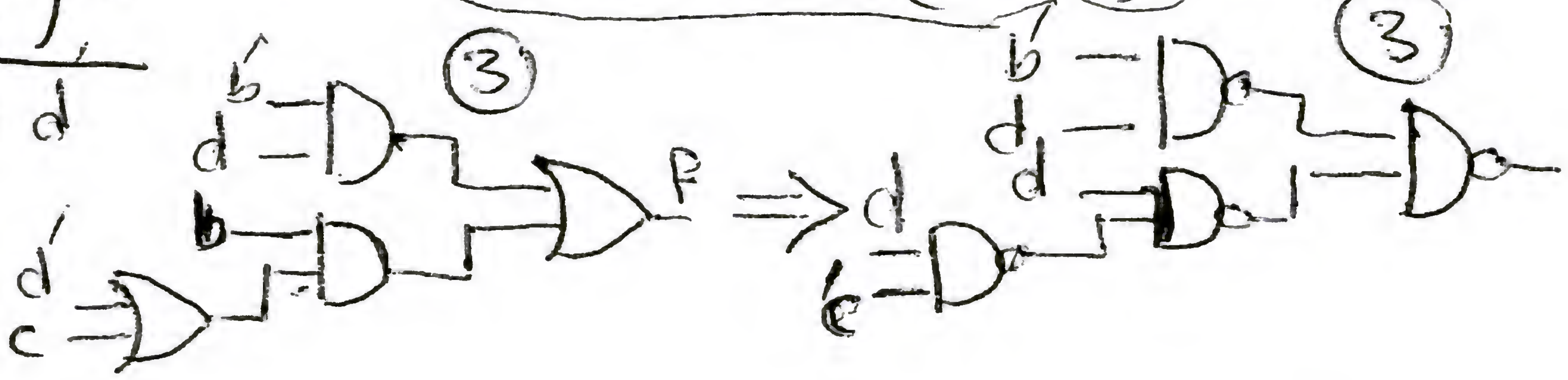
a) Realize the expression $F(a,b,c,d) = \sum m(1,3,4,6,7,9,12) + \sum d(8,11,14,15)$ with a minimum three-level circuit using only two input NAND gates. 13

4

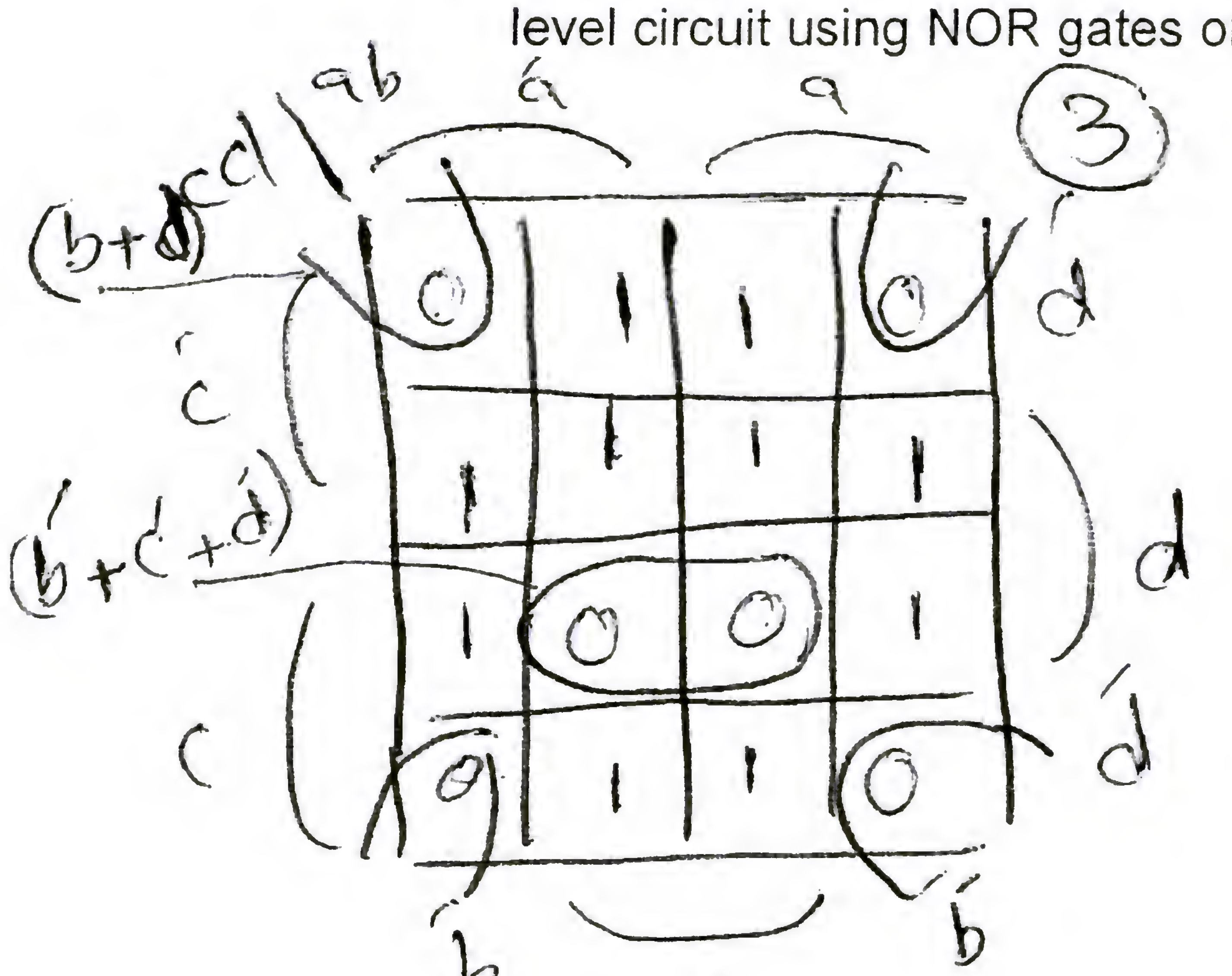


$$f(a,b,c,d) = b'd + bd' + bc$$
$$= b'd + b(d'+c) \quad 3$$

or $f = bd' + b'd + cd$
$= bd' + d(b'+c)$



b) Realize the expression $F(a,b,c,d) = bc' + a'b'd + bcd' + ab'd$ with a minimum two-level circuit using NOR gates only. 12



$$f(a,b,c,d) = (b+d)(b'+c'+d') \quad 3$$